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ASSESSMENT OF THE NUTRITIVE VALUE OF WEANING FOOD DEVELOPED FROM YELLOW MAIZE AND SORGHUM FORTIFIED WITH BAMBARA NUTS AND GROUNDNUTS

by

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Abstract

Weaning food was formulated based on locally available cereals, yellow maize (*Zea mays*), sorghum (*Sorghum bicolor*) and legumes: Bambara nuts (*Vigna subterranean*) and groundnuts (*Arachis hypogaea*). The nutritive value was evaluated and compared with commercial formula and recommended daily allowance (RDA). The blends were divided into three. The first blend was made up of yellow maize, sorghum, Bambara nuts (70:20:10), the second blend was made up of yellow maize, sorghum, groundnuts (70:20:10) while the third blend was made up of yellow maize, sorghum, groundnuts and Bambara nuts (60:20:10:10). The proximate composition and mineral contents of the formulated diets were determined. Sensory evaluation was also carried out and results indicated that all three diets met the RDA values for children and also compared favourably with the commercial weaning diets which served as the control and therefore they were acceptable by the panelist.

Keywords: Assessment, Weaning foods, Development, Cereals

Introduction

The United Nations Standing Committee on Nutrition [UNSCN] pointed out that malnutrition is directly and indirectly associated with more than 50% of all children mortality, and is the contributor to disease in developing world (SCN, 2004). Malnutrition is thus associated with more than half of all deaths of children worldwide. In Nigeria, and indeed most developing countries, the underlying problems have been identified to include poverty, high cost of first class protein, inadequate nutrient intake particularly during pregnancy, period of rapid growth and complementary feeding in infants, ignorance about nutrient values of foodstuff and parasitic infections (SCN, 2004; WHO, 2000). This problem is exacerbated by the faltering economy, depreciating buying power of the Naira and the declining import of costly protein-rich foods. The use of cereal-legume based food is therefore advocated as alternative protein and energy source for infant and adult food products. In order to help alleviate the ever-increasing problems of malnutrition in developing countries, the need for fortification of popularly consumed low protein staple foods with inexpensive sources of plant proteins that would give weaning foods that are low in viscosity, high in caloric density and with adequate necessary nutrients cannot be overemphasized.

Malnutrition is thus associated with more than half of all deaths of children worldwide (Sobo and Oguntola, 2006). This tends to reduce the population of the affected country. Food dependency is typically on breast milk which is reputed to be the best for human infants. The growth of the infant in the first or second years is very rapid and breast feeding alone will not meet the child nutritional

requirement. After about four months of age the child needs supplementary feeding (Ijarotimi&Famurewa, 2006). As a result many brands of preparatory weaning foods has been developed and marketed in most developing countries including Nigeria (Okafor, J.N.C., A.U. Ozumba, T. Osibanjo, L.I. Onu, A.M. Daodu and O.O. Olatunji, 2008). In these countries, the child is usually weaned into a porridge prepared from cereal flour such as maize which is characterized by bulky, high viscosity and low energy density per unit volume of the food, thus necessitating frequent feedings to meet the daily energy requirements of the child. Apart from energy, the food is usually inadequate in other nutrients, leading to widespread protein energy malnutrition and its complications, during the weaning period (WHO, 2000; Ijarotimi&Famurewa, 2006; Ugwu, 2009). Nigeria is no exception, as most children are weaned onto Ogi, a gruel made from fermented corn (Ugwu, 2009). The situation is even more critical as prices of commercial weaning food products are too expensive for many mothers (Njoki&Fallar, 2001; Ijarotimi, et al 2006; Inyang&Offiong, 2010). Thus the need to have maximum utilization of commonly available cheap cereals to formulate weaning foods that would be low in viscosity, high in caloric density and with adequate necessary nutrients (Ozumba, A.U., O.O. Olatunji and J.A. Odunfa, 2002). In Nigeria, many attempts to produce weaning food which are quite rich in protein and other nutrient by combination of cereals with various sources of rich protein from animal, legumes and oil seeds has been reported (Ozumba et al., 2002; Okafor et al., 2005, 2008; Okafor and Ozumba, 2006).

Bambara nut (*Vignasubterranea*) is among the legumes that are widely cultivated in Nigeria and it is underutilized. It has not been adequately exploited, as human food because of constraints like hard to cook phenomenon, strong beany flavour, presence of anti-nutrients and poor dehulling and milling characteristics. Bambara groundnut is essentially grown for human consumption. The seed is regarded as a balanced food because when compared to most food legumes. On the average, the seeds were found to contain 63% carbohydrate, 19% protein and 6.5% oil. Its protein content can be used to fortify our mostly starchy foods. (Mbata, T.I., Ikenebomeh, M.J., Ahonkhai, I. (2007)).

Maize (*Zeamays*) grains are used in the production of several traditional foods, unfortunate they lack adequate micronutrients. In order to help alleviate the ever-increasing problems of malnutrition in developing countries, the need for fortification of popularly consumed low protein staple foods with inexpensive sources of plant proteins cannot be overemphasized. Hence, this study was conducted to prepare a weaning food formulation using locally available and cheap raw material, viz., yellow maize, sorghum, Bambara nut and groundnut. The nutritional properties of the formulation was evaluated and compared with commercially available weaning foods as well as its ability to meet Recommended Dietary Allowance (RDA) for children.

Materials and methods

All the raw materials (yellow maize, sorghum, Bambara nut and groundnut) were purchased from Oja Oba market in Ilorin, Kwara state, Nigeria. The weaning diets were prepared according to the method described by (Agunbiade&Ojezele, 2010) with slight modification. Raw materials were cleaned by removing insect damaged grains and other extraneous materials. The cereals were then roasted individually under a controlled heat. The same process was done to the legumes as they were sorted, washed with tap water and air dried. The Bambara nuts and groundnuts were separately roasted under a controlled heat, and later allowed to cool.

Formulation of weaning blends

The composite diets were formulated as follows

Blend 1: Yellow maize, sorghum, Bambara nuts (70:20:10)

Blend 2: Yellow maize, sorghum, Groundnuts (70:20:10)

Blend 3: Yellow maize, sorghum, Bambara nuts, Groundnuts (60:20:10:10)

Each of the Diet mixture were separately measured and mixed in a mixer grinder into smooth homogeneous powder. They were then stored in separate air tight plastic containers in the refrigerator until needed for analysis.

The weaning food formulations were individually prepared into gruel with boiling water. 20g of each sample was mixed with boiling water to form an instant gruel.

Analytical Procedure

The proximate and mineral compositions of the cereal- legumes based diets were carried out using the methods of Analysis of Official Analytical Chemists (A.O.A.C., 1990).
Sensory Evaluation of Diets.

Sensory characteristics of the weaning foods were assessed by 15 untrained panelists of nursing mothers from University of Ilorin community. The panelists were in good health and are familiar with the taste, flavour and other attributes of weaning food. The gruels were prepared and served in sensory evaluation cups. The samples were assessed for colour, taste, flavour, aroma, texture and overall acceptability. The judges were instructed to sip water before and after assessing each product. The samples were assessed using a 9 point hedonic scale ranging between 9 (like extremely) to 1 (dislike extremely).

Statistical analysis

The mean and standard deviation of all data generated were subjected to analysis of variance (ANOVA) using Statistical Package for Social Sciences

Results

Table 1 shows the proximate composition of the three local blends formulated cereals diets. It revealed that the constituents' nutrient parameters in blend 1 were the lowest among the three blends and it is now considered to be significantly poor in nutrient composition compared to blend 2 and 3. It also revealed that blend 2 yielded 33.55% fat as against 30.9% fat in blend 3. Blend 3 yielded 77.14% CHO, 50.14mg/l Ca, and 3.84mg/l Fe as against 73.7% CHO, 48.17mg/l Ca, and 3.67mg/l Fe for blend 2. This implied that blend 2 is significantly richer in fat than blend 3 and blend 3 is significantly richer in carbohydrate, calcium and iron than blend 2.

The results indicated no significant difference ($p>0.05$) in the proportions of ash, crude fibre, and protein contents between both blends. Hence, both blends are regarded to contain comparable proportions of ash and crude fibre. However, the ash and crude fibre compositions were higher in blend 3 (7.3% and 6.84% respectively) than in blend 2 (7.15% and 6.77% respectively). Thus implying that blend 3 is richer in ash and crude fibre nutrients.

The proximate composition of the three cereal/legumes blends were compared to that of standard cereal (Nestle Cerelac). The findings revealed that the standard cereal was lower in ash (2.6%), Moisture (2.5%), crude fibre (3.0%) and protein (15.0%) than all 3 blends. On the contrary, the Carbohydrate (413), Ca (420), and Fe (10.0) contents of the cerelac brand were higher than that of the three blends. Titratable Acidity and Magnesium nutrients were not available in the cerelac cereal.

Table 1: Nutritional composition of the weaning diets formulation.

PARAMETER	BLEND 1	BLEND 2	BLEND 3	*CERELAC
TTA (%)	$5.23 \pm 0.18^{(a)}$	$5.72 \pm 0.18^{(ab)}$	$6.27 \pm 0.18^{(b)}$	NA
Ash (%)	$5.35 \pm 0.14^{(a)}$	$7.15 \pm 0.14^{(b)}$	$7.3 \pm 0.14^{(b)}$	2.6
Moisture (%)	$7.64 \pm 0.17^{(a)}$	$8.3 \pm 0.17^{(b)}$	$8.1 \pm 0.17^{(ab)}$	2.5
Fat (%)	$7.64 \pm 0.59^{(a)}$	$33.55 \pm 0.59^{(c)}$	$30.9 \pm 0.59^{(b)}$	9.0
Crude fibre (%)	$5.18 \pm 0.09^{(a)}$	$6.77 \pm 0.09^{(a)}$	$6.84 \pm 0.09^{(b)}$	3.0
Protein (%)	$33.61 \pm 0.35^{(a)}$	$36.07 \pm 0.35^{(a)}$	$36.07 \pm 0.35^{(b)}$	15.0
Carbohydrate (%)	$72.4 \pm 0.23^{(a)}$	$73.7 \pm 0.23^{(a)}$	$77.14 \pm 0.23^{(c)}$	413.0
Ca (mg/l)	$45.58 \pm 0.16^{(a)}$	$48.17 \pm 0.16^{(a)}$	$50.14 \pm 0.16^{(c)}$	420.0
Mg (mg/l)	$0.16 \pm 0.01^{(a)}$	$0.18 \pm 0.01^{(a)}$	$0.18 \pm 0.01^{(a)}$	NA
Fe (mg/l)	$3.27 \pm 0.04^{(a)}$	$3.67 \pm 0.04^{(a)}$	$3.84 \pm 0.04^{(c)}$	10.0

KEY

TTA is Titratable acidity of blends

Blend 1 is the mixture of Yellow maize, sorghum, Bambara nuts (70:20:10)

Blend 2 is the mixture of Yellow maize, sorghum, Groundnuts (70:20:10)

Blend 3 is the mixture of Yellow maize, sorghum, Bambara nuts, Groundnuts (60:20:10:10)

*Cerelac is a commercial weaning food from nestle

Table 2: Sensory Evaluation of the Blends

PARAMETER	BLEND 1	BLEND 2	BLEND 3
Taste	6.93	7.13	6.67
Colour	6.2	6.33	6.4
Aroma	6.47	6.53	6.53
Flavour	6.53	6.53	6.27
Texture	4.93	4.93	5.73
General Acceptability	5.93	6.4	6.4

A total number of 15 respondents were sampled to participate in the acceptability test as shown in Table 2. The findings on the acceptability of the three blends of cereals revealed that blend 2 and blend 3 had better acceptance than blend 1. This corroborates the findings earlier stated in Table 1. This is underscored by the fact that blend 3 was richest in colour (6.4 ± 1.55) and texture (5.73 ± 2.31), while blend 2 was the richest in taste (7.13 ± 1.25). Also, both blends that is blend 2 and blend 3, were rated the same in terms of their aroma (6.53 ± 1.06), and general acceptability (6.4 ± 1.3). This revealed that generally, blend 2 and blend 3 were better accepted than blend 1.

Discussion of results

The study showed that the use of legumes as a fortifying agent has been reported to improve the protein content of the Cereal-based diet. The protein content of the weaning food blends was higher than the commercial weaning foods, this is in line with the work of Modu S. Bintu BP, Hauwa H, Falmata AS, AliyuDaja and Maryam BK(2017).

The carbohydrate content of the weaning food blends was lower than the commercial weaning food. Similar result was reported by Ikujenlola and Adurotoye, (2014) in the evaluation of quality characteristics of high nutrient dense complementary food from mixtures of malted quality maize and steamed cowpea. Madukwe Edith U., Okoye V., AyoguRufina N. B. and Okechukwu Franca(2013) also reported that legumes store more energy in form of fat than cereals.

This is in agreement with the reports of Modu., et al. (2010) in the production of Ogi from pearl millet and cowpea. This is also similar to work of Modu., et al. (2017), who observed a decrease in carbohydrate content of maize based food blend fortified with cowpea bambaranut.

Protein content of complementary foods is a particular relevant issue in infant feeding, where Protein Energy Malnutrition (PEM) has continued to pose challenges in the research area.

Blend 2 and 3 when compared with blend 1 showed higher protein contents. This could be due to the inclusion of ground nuts and Bambara nut in blend 2 and blend 3. Both food commodities have been recommended for infant feeding due to their positive contribution to protein nutritional level. (Mbata et al, 2007)

It is also clear from the result that the fortified foods were nutritious, since the products provided one third of the recommended dietary allowance (RDA) with respect to protein (Table 1) as recommended by food and agriculture organization and national institute of nutrition for children and rural mothers. (FAO/WHO 2005). The proximate characteristics of the fortified food was within the range reported for

weaning and supplementary food. Variations in carbohydrate content were observed with Bambara nut and groundnut concentration. The results showed that the carbohydrate content decreased. This agrees with the observation that addition of legume decreases the carbohydrate content of maize-based traditional foods (Sefa-Dedeh et al., 2001). The study has revealed

that fortification of cereal meal (maize and sorghum) with legume (Bambara nut and ground nut) is able to alleviate problems of protein energy malnutrition (PEM). The fortified foods prepared from legumes and cereals were nutritious and conformed to specifications as recommended by national institute of nutrition and food and agriculture organization (FAO) to combat malnutrition especially in low economic groups. It has special importance for use in weaning foods, catch-up growth and may improve birth weights.

The local diets were observed to be low in mineral contents relative to the proprietary formula and RDA's. The high content of anti-nutritional factors and poor bioavailability of minerals in plant based foods as well as losses during processing play a vital role in micronutrient deficiency. It is therefore obvious that even the low mineral contents in the local diets may not be available or utilized completely by the child. Further fortification with micronutrients may therefore be necessary to adequately complement the breast milk. The high moisture content of the local diets may affect the storage quality of the foods.

The low concentration of calcium recorded in this study tallies with the findings of Modu, et al. (2017) who found that cereals are poor in this mineral. The magnesium content of the weaning food blends was higher than the commercial weaning food.

Saleh, et al. (2015) reported similar findings in the effect of fortification of rice with banjara bean and sesame. Magnesium is needed for more than 300 different enzymes systems in the body. It is important in formation of Adenosine triphosphate, storage of carbohydrates and proteins in nerve and muscle activity (Kumkum, et al. 2010). The organoleptic evaluation showed that, combinations of cereals and legumes to prepare the food mixtures, was liked by the trained panelists (Table 2). None of the panelists developed any side effects like diarrhea and vomiting after the sensory evaluation.

Conclusion

The study revealed that ready to eat complementary food products formulated from locally available food commodities, can meet the macro nutritional needs of infants and children, it increases the protein contents, crude fat and other nutrients analysed. It also revealed that blend 2 which is 70% yellow maize, 20% sorghum, 10% Groundnut and blend 3 which is 60% yellow maize, 20% sorghum, 10% Bambara nut and 10% Groundnut.

Recommendations

It is recommended that the digestibility and bio availability of the macronutrients in these local weaning diets should be investigated.

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